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A multi-chamber stimulation device and associated method reliably and automatically verify capture during cardiac stimulation. The stimulation device achieves efficient synchronous biventricular stimulation by using cross-chamber electrode configurations to minimize pacing energy requirements, and further achieves reliable capture detection by using cross-chamber sensing electrode configurations to minimize the effect of lead polarization. During cross-chamber stimulation, a biphasic pulse, a balanced monophasic pulse, or a biventricular pacing pulse may be delivered. By delivering a biventricular pacing pulse, a larger potential difference is established across the ventricles, improving the recruitment of Purkinje fibers and other conductive elements of the cardiac tissue, thus enhancing conduction of the stimulating pulses through the cardiac tissue.